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DISEASES OF APPLES ON THE MARKET.[1]

A Statistical Study Based on Certificates Issued by the Food Products Inspection Service of the Bureau of Agricultural Economics during the Period from November 1, 1917, to July 1, 1921.

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INTRODUCTION.

Apples are the most important fruit crop of the United States. Every year they outrank citrus fruit, peaches, and strawberries, both in size of crop and in actual money value. According to statistics published in the Yearbooks of the United States Department of Agriculture for 1920 and 1922, the average annual total crop for the five years from 1916 to 1920, inclusive, was 179,208,000 bushels. The average annual commercial crop (apples sold or to be sold) for the same five years was 80,337,000 bushels (estimated). The commercial crop during this period was therefore about 45 per cent of the total production. The total 1920 crop, 223,677,000 bushels, at farm prices of December was worth approximately $256,781,000. Forty-five per cent of that sum, or $115,551,000, can be assumed as the minimum value of the commercial crop. It was certainly worth more than that, but there is no way of telling how much more.

Reductions in size and value of the apple crop must therefore be reckoned on a basis that usually approximates $200,000,000 for the total crop and at least $100,000,000 for the commercial crop. They are, consequently, of decided interest to the whole country. In the field, such reductions are brought about by various climatic conditions, by plant diseases, and by animal and insect pests. Estimates of loss caused in the field by plant diseases alone to the 1919 crop varied from 5 to about 12 per cent of the total crop. But nearly half of every apple crop is sold for consumption as fresh fruit. It must therefore pass through the various processes incident to marketing and so is in danger of further loss from several causes, the most important of which are (1) too high or too low temperature, (2) disease, and (3) insect pests. Too high temperature ripens apples too fast, so that they must be sold at a partial loss or be a total loss. Too low temperature results in freezing injury, which may affect only a part, or under extreme conditions all, of the fruit in a carload or storage lot; in either case the affected fruit must be sold at a loss. Insect pests, chiefly codling-moth larvæ, may during the marketing process continue the destructive work on apple flesh which they began in the orchard. And here again some one must take a loss when the fruit is sold.

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[1] It has been the writer's duty to give instruction and advice to the inspectors of the Food Products Inspection Service of the Bureau of Agricultural Economics in the identification and diagnosis of fruit diseases as these are found on the markets and also to investigate these diseases so as to insure correct diagnosis. The data presented in this bulletin were collected and tabulated while the writer was engaged in this cooperative work.

The term disease includes (1) rots, (2) blemishes such as scald and scab, (3) conditions within the fruit such as water-core and internal breakdown. Some diseases originate in the field; others originate, or at least become apparent, only during the marketing process. But whatever their origin or time of development, if considered as a whole they are found to cause a loss which is greater than that caused either by insects or directly by faulty temperature conditions. There is of course a close relation between temperature and the amount of disease that develops; the reference in the above comparison is merely to the effect of temperature in bringing about either overripeness or freezing injury.

There is only one set of reports which shows the amount of loss due to disease for any considerable portion of the commercial crop. These data are found in the certificates issued by inspectors of the Food Products Inspection Service of the Bureau of Markets (now Bureau of Agricultural Economics) on carloads of apples examined by them at terminal markets. It is desirable, therefore, to make use of such data, and the present bulletin embodies an analysis and discussion of those available for the four-year period ended June 30, 1921.

The Food Products Inspection Service was established in August, 1917, and began operations November 1, 1917. From the latter date until July 1, 1921, its inspectors examined 11,264 cars of apples, distributed as follows:

November 1, 1917, to June 30, 1918 (1917 crop), 991 cars.
July 1, 1918, to June 30, 1919 (1918 crop), 1,589 cars.
July 1, 1919, to June 30, 1920 (1919 crop), 5,342 cars.
July 1, 1920, to June 30, 1921 (1920 crop), 3,342 cars.

These inspections covered both the barrel or eastern crop and the box or western and northwestern crop and were made in 31 widely distributed principal markets of the country. All of them were made at the request of a financially interested party, some to decide a question of grade, others to determine the amount of decay or other disease, and still others for sales purposes; that is, so the car could be sold on the basis of Government inspection. They cover slightly less than 3 per cent of the total car-lot shipments (382,757) during the four-year period and for that reason furnish no adequate basis for conclusions about the condition of the whole crop. It should not be assumed, however, that they entirely misrepresent the condition, since out of 11,264 cars inspected only 5,222, or roughly 46 per cent, showed disease. The least that can be said is that the inspections give more detailed and accurate information about a small part of the commercial crop than has hitherto been available about any part of it except a few scattered carloads or storage lots.

TABULATION OF DATA.

Data from the certificates issued on cars showing disease have been considered under two main heads, depending on whether they relate to cars from the West or Northwest (the box crop) or to cars from the Middle West or the East (the barrel crop). Within each of these two groups the data have been tabulated according to the various diseases, by years, months, varieties, States, and inspection offices. The tabulation, or analysis, is thus based solely on the certificate statements, which give the date and place of inspection, the variety inspected, the kind of shipment (box, barrel, or bulk), the place of origin of the shipment, and the condition of the fruit, including the amount and kind of disease found by the inspector. Such an analysis makes possible several interesting comparisons, and through them throws some light on the general question of what factors determine the keeping quality of apples; it can not, however, give a definite and exhaustive answer to that question, since the complete history of the shipment is not known and can not be deduced from the certificate in any single instance. Nothing is known, concretely, for any given carload, about the conditions under which the apples were grown, how they were handled during the picking and packing process, and what kind of treatment they received in transit and in storage. It is possible to tell in a general way from the variety name and the date of the certificate about how much time had elapsed since the apples were picked and, for storage varieties, about how long they had been in storage. It is also allowable to assume for the box crop rather more careful grading and methods of handling than are in use for the barrel crop. But assumptions are not proof, and it is inadvisable to attempt proof when the data are inadequate. Consequently, the discussion which accompanies the tables (under "Analysis of data") is limited to pointing out what seem to be obvious facts and to suggesting in a few other places what the relation may be between the figures in the tables and the probable conditions under which the apples were grown and marketed.

There is some chance for error in attempting to set a definite percentage for a certain disease in a given carload on the basis of the certificate statement. That statement frequently gives a range (blue-mold rot ranging from 5 to 25 per cent, in most boxes 10 to 15 per cent) rather than a single average percentage and for strict accuracy should be interpreted by the inspector who wrote it. The arbitrary fixing of such a percentage by anyone else for use in tabulations can be justified, however, on the following grounds:

1. In the settlement of controversies over the condition of apple shipments, financially interested parties make frequent and mutually satisfactory use of such a percentage, deduced from the certificate statement. That is, they find it accurate and reliable for the settlement of deals in which money is involved.

2. Four years' experience in the making of apple inspections has shown that apples run more uniform throughout the load than do other perishable products, excepting possibly citrus fruit. Consequently, a percentage based on the examination of 10 or 12 boxes or barrels can be taken as approximately the true one for the whole carload.

3. As pointed out above, the certificate statements furnish more information about the condition of apples arriving on the market than is now available from any other source.

It is felt, therefore, that the analysis here presented furnishes a trustworthy basis for comparison as to disease in the cars inspected between varieties, States, months, years, and inspection offices; also between the box and the barrel crops. Throughout the tables percentages are given to the first decimal, though it is evident that any figure beyond the decimal point is of doubtful value except where large numbers of cars are involved.

It should be added that the word "percentage" as used in this bulletin means the proportion of diseased apples to the total quantity in the carload or storage lot and has no reference to the amount of rot or other disease on individual fruits. Thus, 10 per cent of blue-mold rot means that 10 per cent of the apples showed the rot in some degree, but not that 10 per cent of them were totally rotted. For commercial purposes, the first condition is practically as serious as the second. On the market, an apple even slightly rotted is a cull. But with diseases other than rots the situation is different; 20 to 30 per cent of slight scald or scab usually means a smaller reduction in the selling price than 10 per cent of bad scald or scab. The same is true for bitter-rot, Jonathan spot, water-core, and a number of others. It is apparent, therefore, that the present analysis is incomplete and that any subsequent report should take into consideration both the percentage of diseased apples and the extent to which those apples are diseased.

In a number of the tables that follow there are, aside from the first or "Classification" column and the second column for total number of cars showing disease, four others for rots, scald, other diseases, and a disease index. The percentages shown in the third, fourth, and fifth columns were obtained by adding together, for each column, all percentages of rot, scald, or other diseases, respectively, that were recorded on the certificates and dividing by the total number of cars showing disease, for each month, variety, State, or office. Such a procedure may seem to involve the pyramiding of percentages and would actually do so were it not for the fact that when as many as three diseases occur in a car they are usually found to be a rot, scald, and some other disease. It does not often happen that a car shows more than one rot or more than one "other disease" aside from scald. And even when two rots or two "other diseases" are recorded, it has usually been found possible to segregate percentages and avoid pyramiding in the summary tables.

As for the sixth or index column, pyramiding is involved in every figure which appears in it. That is to say, the very fact of obtaining such a figure implies that each disease appears on a different lot of apples in the car, which is not true. In a car which shows 5 per cent of rot, 20 per cent of scald, and 10 per cent of some other disease, there is not necessarily 35 per cent of the carload affected with disease. There may be only 20 or 25 per cent of it so affected. The disease index is, therefore, not a true percentage, but merely a sum of percentages, and has value, if at all, only when used as a basis of comparison between years, months, varieties, or any other coordinate elements in the tabulation.

In Tables 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, and 18 percentages are calculated on the basis of all cars showing disease of any kind.

In Tables 1, 2, 6, 17, 19, 20, 21, 22, and 23 the percentages are calculated on the basis of cars showing some particular disease or diseases.

ANALYSIS OF DATA.

Summary Tables 1 and 2 bring out several interesting facts, the most striking of which is that in the crops of 1918, 1919, and 1920, both barrel and box, blue-mold rot was more common and occurred in a larger proportion of the cars examined than any other disease. In both the barrel and the box crop for 1917 the most common disease noted was "decay." The service was new, and the inspectors probably did not feel themselves experienced enough to distinguish the different rots. To be on the safe side they called most rots "decay."

These tables also show that next to blue-mold rot and decay the most common disease in the box crop was scald; in the barrel crop, black-rot, with scald ranking fourth. In the box crop, during the four years, there were 3,674 cars that showed disease, of which number 2,954 showed blue-mold rot, 219 decay, and 1,191 scald. In the barrel crop, out of 1,548 cars showing disease 997 showed blue-mold rot, 310 decay, 243 black-rot, and 208 scald.

Diseases common to both crops were blue-mold rot, decay, scald, Alternaria rot, scab, soft scald, bitter-pit, and internal breakdown. Diseases reported in the box crop only were anthracnose, Jonathan spot, water-core, and drought-spot; in the barrel crop only were black-rot, brown-rot, bitter-rot, Rhizopus rot, pink-mold rot, gray-mold rot, blotch, rust, fruit-spot, and sooty blotch. Total diseases reported for the box crop, 12; for the barrel crop, 18.

The term anthracnose as used in this bulletin applies to the true anthracnose found in the humid apple districts of Oregon and Washington and also to an anthracnoselike rot found in a considerable number of cars from the irrigated apple districts of Washington during the late winter and spring of 1921.

BOX CROP: DISEASE BY YEARS.

Figures for single diseases by years are given in Table 1, but the general condition of the crop as affected by all diseases is better shown in Table 3.

From Table 1 it appears that in the cars which showed disease, the disease index was greatest in 1917 and least in 1919, with an average for the four years of 12.6. From 1918 to 1920 the percentage of rot decreased by three-fifths and the percentage of scald quadrupled. During the same period there was a ninefold increase in other diseases, although the percentage of these was not large at any time—that is, when calculated on the basis of all cars showing disease. When calculated on the basis of cars showing a particular disease, the percentage for some of these diseases is quite high. For example, the average percentage of water-core in 47 cars (Table 1) was 19.6; of internal breakdown in 81 cars, 13.5.

TABLE 1.—*Summary, box crop, all years and all diseases.*

Year.	Total cars.	Blue-mold rot.		Decay.		Scald.		Anthracnose.		Alternaria rot.		Jonathan spot.	
		Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
1917	233	62	7.5	150	10.4	98	19.0	------	------	------	------	10	15.0
1918	219	162	13.0	40	8.1	31	13.1	2	14.0	------	------	------	------
1919	2,084	1,963	7.6	19	5.8	425	17.6	23	2.7	20	7.6	3	12.3
1920	1,138	767	6.0	10	4.3	637	13.8	98	6.8	17	4.5	15	12.0
Total or average	3,674	2,954	7.5	219	9.3	1,191	15.6	123	6.0	37	6.2	28	13.1

TABLE 1.—*Summary, box crop, all years and all diseases*—Continued.

Year.	Bitter-pit.		Scab.		Water-core.		Internal breakdown.		Drought-spot.		Soft scald.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
1917	3	5.0	2	1.5	------	------	------	------	------	------	------	------
1918	2	11.5	------	------	2	5.0	2	7.0	1	10.0	1	10.0
1919	8	4.2	2	14.0	2	6.0	3	20.3	------	------	------	------
1920	9	7.4	1	7.0	43	21.0	76	13.4	1	12.0	8	6.0
Total or average	22	6.3	5	7.6	47	19.6	81	13.5	2	11.0	9	6.4

BARREL CROP: DISEASE BY YEARS.

Figures for single diseases are given in Table 2, but as with the box crop the general condition for each year as affected by all disease is better shown in Table 3. From this table it appears that percentages of rot, scald, other diseases, and the disease index were greatest in 1917 and that while there was no regular decrease in any of them from that time on the percentages in 1920 were less than in 1917, and for rots and the disease index less than in 1918 and 1919. The general average of the disease indices for all years was 16.8.

TABLE 2.—*Summary, barrel crop, all years and all diseases.*

Year.	Total cars.	Blue-mold rot.		Decay.		Scald.		Black-rot.		Brown-rot.		Bitter-rot.	
		Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
1917	53	12	12.6	30	19.9	16	31.8	2	19.0	------	------	2	3.0
1918	117	23	8.0	79	13.5	6	30.5	3	15.6	------	------	1	9.0
1919	570	327	11.1	164	17.7	49	40.0	126	10.9	------	------	11	6.9
1920	808	615	6.7	37	5.2	137	29.0	112	5.7	20	4.2	2	5.0
Total or average	1,548	977	8.3	310	15.3	208	31.9	243	8.6	20	4.2	16	6.3

Year.	Total cars.	Alternaria rot.		Rhizopus rot.		Pink-mold rot.		Gray-mold rot.		Scab.		Blotch.	
		Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per	Cars.	Per cent.
1917	------	------	------	------	------	1	31.0	------	------	13	17.0	3	45.3
1918	------	------	------	------	------	2	12.0	------	------	17	10.1	2	5.0
1919	------	------	------	6	26.1	6	14.6	------	------	14	12.2	------	------
1920	------	3	3.6	18	13.6	37	15.7	2	2.0	78	13.2	12	15.2
Total or average	------	3	3.6	24	16.8	46	15.7	2	2.0	122	13.0	17	19.3

Year.	Total cars.	Rust.		Fruit-spot.		Sooty blotch.		Soft scald.		Bitter-pit.		Internal breakdown.	
		Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
1917	------	2	9.5	------	------	3	34.3	------	------	------	------	------	------
1918	------	------	------	------	------	4	51.2	------	------	------	------	------	------
1919	------	------	------	------	------	4	11.0	------	------	7	9.4	3	7.0
1920	------	2	6.5	2	16.0	9	17.6	2	35.0	12	13.6	8	26.3
Total or average	------	4	8.0	2	16.0	20	25.5	2	35.0	19	12.1	11	21.0

TABLE 3.—*Disease in barrel and box crops, by years.*

Year.	Cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
Box crop:		*Per cent.*	*Per cent.*	*Per cent.*	
1917	233	8.7	8.0	0.7	17.5
1918	219	11.2	1.9	.2	13.4
1919	2,084	7.3	3.5	.1	11.0
1920	1,138	4.7	7.7	1.9	14.4
Total or average	3,674	6.8	5.0	.7	12.6
Barrel crop:					
1917	53	15.5	9.6	9.0	34.1
1918	117	11.3	1.1	3.3	15.7
1919	570	14.5	3.4	.5	18.4
1920	808	7.3	5.0	2.3	14.6
Total or average	1,548	10.5	4.3	1.9	16.8

[1] The disease index is not a true percentage but merely a sum of percentages (see p. 4) and is of value only as a basis of comparison between years, months, varieties, or any other coordinate elements in the tabulations.

As with the box crop, the percentage of "other diseases" was low when calculated on the basis of all cars showing disease, but fairly high for some of them when calculated on the basis of cars showing that particular disease. For example (Table 2), there was an average of 16.8 per cent of Rhizopus rot in 24 cars, 19.3 per cent of blotch in 17 cars, and 25.5 per cent of sooty blotch in 20 cars.

The disease index in the barrel crop, 16.8, was a third larger than the corresponding number, 12.6, in the box crop. (Table 3.)

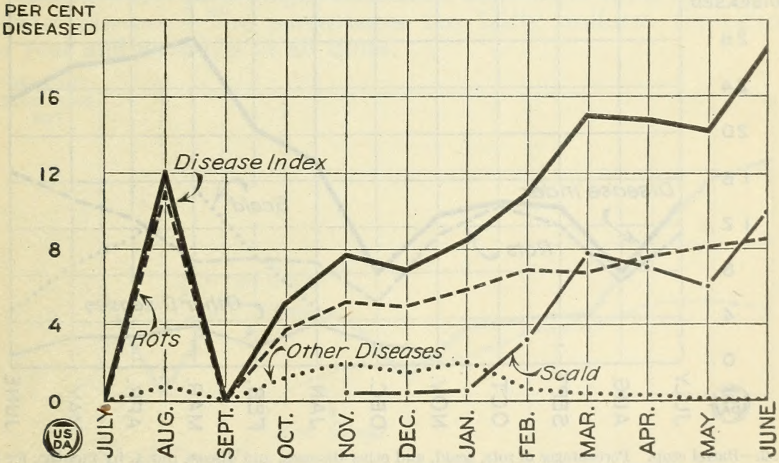

FIG. 1.—Box crop. Percentages of rots, scald, other diseases, and disease index, by months, for the four crop years, 1917 to 1920, inclusive. The percentages are calculated on the basis of all cars showing disease of any kind.

BOX CROP: DISEASE BY MONTHS.

Rots.—With the two minor exceptions in December and March, there was a fairly regular increase (see Table 4 and fig. 1) from 3.8 per cent in October to 8.5 per cent in June, a condition probably due to the further development in storage of rots already present when the fruit went into storage. It may have been due in part also to further infection during the storage period, but this seems unlikely, since most of the rotting was caused by blue mold, which, according to the work of Brooks and Cooley[2], can not cause much new infection if the temperature is kept below 50° F.

TABLE 4.—*Summary, box crop, by months, 1917 to 1920.*

Month.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
		Per cent.	*Per cent.*	*Per cent.*	
July					
August	6	(2)		11.1	12.0
September					
October	89	3.8		1.3	5.2
November	207	5.2	(2)	2.0	7.7
December	322	5.0	(2)	1.5	6.9
January	318	5.8	(2)	2.1	8.5
February	498	6.9	3.2	(2)	10.9
March	889	6.8	7.8	(2)	15.0
April	647	7.6	7.0	(2)	14.8
May	485	8.1	6.0	(2)	14.2
June	213	8.5	9.9	(2)	18.5
Total or average	3,674	6.8	5.0	(2)	12.6

[1] See foot note to Table 3. (2) Less than 1 per cent.

The proportions of scald before February and of "other diseases" after January were less than 1 per cent and are so indicated in the table. Delay in the appearance of scald is to be expected every year. It never develops early except on Grimes Golden and a few other fall varieties. Practical disappearance of "other diseases" after January is of no particular significance. These diseases never were found in large percentage except in an occasional car; as, for example, in August, 1920, when two of the six cars inspected showed an average of 8 per cent of bitter-pit and two others 25 per cent each of internal breakdown.

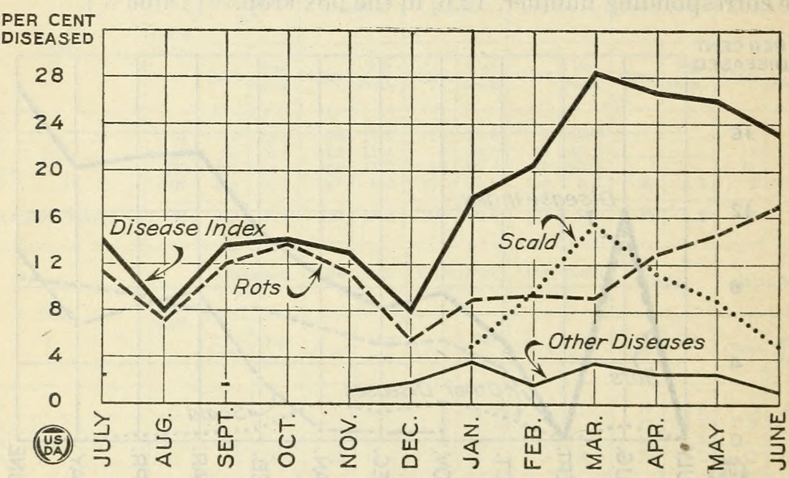

FIG. 2.—Barrel crop. Percentages of rots, scald, and other diseases, and disease index, by months, for the four crop years, 1917 to 1920, inclusive. The percentages are calculated on the basis of all cars showing disease of any kind.

Scald.—Scald first appeared in November, but, calculated on the basis of all cars showing disease, was of little importance until February, rose decidedly in March, and was at its highest in June. It was reported from the largest number of cars in March.

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[2] Charles Brooks and J. S. Cooley. Temperature relations of apple-rot fungi. *In* Jour. Agr. Research, v. 8, p. 139–163. 1917.

Other diseases.—For other diseases than rots and scald, the average after January was less than 1 per cent. The disease index increased from October until June, but not so regularly as did the percentage of rots alone.

BARREL CROP: DISEASE BY MONTHS.

Rots.—The figures in Table 5 (see also fig. 2) show an irregular condition from July to December, inclusive; they were lowest in December and increased steadily from then on until June.

TABLE 5.—*Summary, barrel crop, by months, 1917 to 1920.*

Month.	Total. cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
		Per cent.	*Per cent.*	*Per cent.*	
July	49	11.3	----------	2.4	13.9
August	86	7.0	----------	(2)	7.9
September	151	12.0	----------	1.6	13.6
October	223	13.7	----------	(2)	14.1
November	244	11.3	----------	1.1	12.9
December	144	5.4	(2)	1.8	8.0
January	139	9.0	4.9	3.6	17.7
February	179	9.3	9.5	1.6	20.5
March	172	9.2	15.4	3.6	28.3
April	84	12.9	11.2	2.6	26.7
May	63	14.5	8.8	2.6	25.9
June	14	17.0	5.0	1.2	23.2
Total or average	1,548	10.5	4.3	1.9	16.8

[1] See footnote to Table 3.

[2] Less than 1 per cent.

Scald.—Scald first appeared in December, was found in the largest number of cars in February, and in the highest (average) percentage in March. The percentages decreased both ways from that point.

Other diseases.—The percentages ran fairly uniform throughout the year and were low at all times.

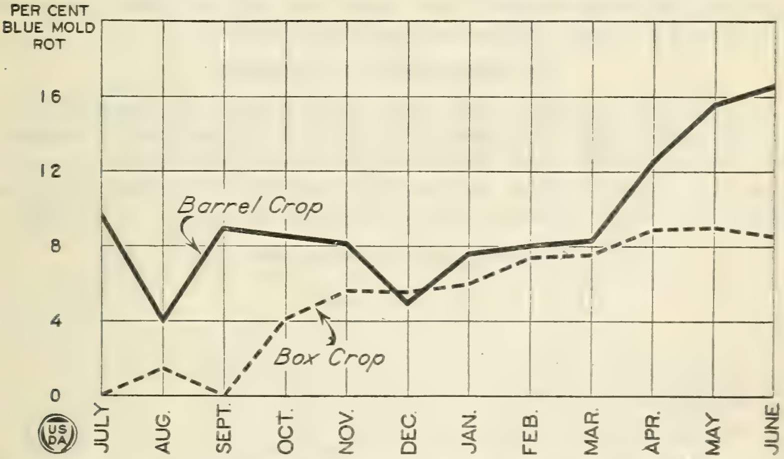

FIG. 3.—Percentages of blue-mold rot in the box and barrel crops, by months, for the four crop years, 1917 to 1920, inclusive. The percentages are calculated on the basis of all cars showing blue-mold rot.

Disease indices.—These take the same general course as that shown by the rots, with an irregular condition for the first six months, a minimum in December, and larger indices from then on, although the maximum, because of adding the scald figures, came in March instead of in June.

TABLE 6.—*Percentage of blue-mold rot in box and barrel crops, calculated on the basis of cars showing blue-mold rot, by months, 1917 to 1920.*

Month.	Box crop.		Barrel crop.	
	Cars.	Per cent.	Cars.	Per cent.
July			18	9.6
August	2	1.5	49	4.0
September			71	8.9
October	82	4.1	131	8.5
November	184	5.6	161	8.1
December	277	5.5	111	4.9
January	278	6.0	97	7.6
February	376	7.4	126	8.0
March	663	7.6	103	8.3
April	489	8.9	60	12.5
May	409	9.0	40	15.6
June	194	8.5	10	16.5
Total or average	2,954	7.5	977	8.3

The box crop showed a fairly uniform rate of increase in the percentages of rot, of blue-mold rot considered alone (see Table 6 and fig. 3), and of disease index from October till June; the barrel crop only from December till June. It is noteworthy, however, that the percentage of blue-mold rot increased much more regularly throughout the season in the box crop than it did in the barrel crop. The difference is probably due to the much larger proportion of summer and fall varieties in the barrel crop (8.3 per cent of all cars inspected) during the early part of the season; that is, until January 1. Such varieties are marketed more often directly from the orchard or from common storage than from cold storage and consequently show great variation in condition. Early varieties appear in the box crop, but in actual carloads shipped they make up only a small proportion (less than 3 per cent) of the total cars inspected.

BOX CROP: DISEASE BY VARIETIES.

The principal thing to be noted here is that the percentages of rots and scald and the disease index (Table 7) are smallest for varieties ordinarily not stored at all and that these figures are successively larger for short-storage and for long-storage varieties. The percentage of "other diseases" decreases with the length of storage.

TABLE 7.—*Summary, box crop, by varieties, 1917 to 1920.*

Variety.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
Varieties usually not stored at all:		*Per cent.*	*Per cent.*	*Per cent.*	
Gravenstein	2	1.0		2.5	3.5
Yellow Transparent	3	1.0		4.0	5.0
Total or average	5	1.0		3.4	4.4
Short-storage varieties:					
Grimes Golden	4	3.2	31.7	2.5	37.5
Jonathan	257	5.2	(2)	3.0	8.4
King David	5	5.6			5.6
McIntosh	6	1.5	(2)	1.0	2.8
Northwestern Greening	1	6.0			6.0
Wagener	10	4.6	8.9	1.4	14.9
Winter Banana	2	1.0	7.5		8.5
Yellow Bellflower	9	4.8	(2)	1.1	6.0
Total or average	294	5.1		2.8	8.8

[1] See footnote to Table 3.

(2) Less than 1 per cent.

TABLE 7.—*Summary, box crop, by varieties, 1917 to 1920*—Continued.

Variety.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.
Long-storage varieties:					
Arkansas (*Mammoth Black Twig*)	8	3.7	17.1	1.8	22.7
Arkansas Black	35	4.7	11.2	(2)	16.2
Ben Davis	66	7.6	2.6	(2)	10.5
Delicious	71	7.0	(2)	----------	7.3
Esopus Spitzenburg	191	8.3	(2)	(2)	8.5
Gano	27	8.0	2.4	----------	10.4
Missouri Pippin	7	10.8	----------	----------	10.8
Ortley	12	3.0	10.2	----------	13.3
Ralls (*Geneton*)	1	3.0	----------	----------	3.0
Rome Beauty	269	5.8	10.8	(2)	17.2
Stayman Winesap	58	4.2	5.7	6.1	16.4
White Pearmain	37	7.5	8.8	(2)	17.0
Winesap	1,656	7.1	4.8	(2)	12.4
Yellow Newtown	264	6.1	12.2	(2)	18.6
Total or average	2,702	6.9	5.8	(2)	13.2
Mixed varieties	669	7.4	3.7	(2)	11.8
Unknown varieties	4	----------	----------	1.7	2.2

[2] Less than 1 per cent.

BARREL CROP: DISEASE BY VARIETIES.

As in the box crop, the percentage of scald and the disease index (Table 8) are seen to increase as the length of the storage period increases. The percentage of rots is least in varieties ordinarily not stored at all, but is slightly smaller in long-storage than in short-storage varieties. The percentage of "other diseases" increases slightly as the length of the storage period increases.

TABLE 8.—*Summary, barrel crop, by varieties, 1917 to 1920.*

Variety.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
Varieties usually not stored at all:		*Per cent.*	*Per cent.*	*Per cent.*	
Alexander	2	18.5	----------	(2)	18.5
Maiden Blush	5	7.2	----------	3.0	10.2
Oldenburg (*Duchess of Oldenburg*)	49	3.7	----------	(2)	4.6
Twenty Ounce	8	6.0	----------	----------	6.0
Yellow Transparent	24	3.7	1.0	(2)	5.5
Total or average	88	4.3	(2)	(2)	5.6
Short-storage varieties:					
Grimes Golden	30	5.6	2.6	3.3	11.6
Jonathan	61	11.2	----------	(2)	11.6
"Russet"	14	11.7	(2)	9.5	20.7
Tompkins King	10	20.1	6.0	----------	26.1
Wealthy	7	4.1	----------	----------	4.1
Total or average	122	10.2	1.2	1.9	13.4
Long-storage varieties:					
Arkansas (*Mammoth Black Twig*)	6	10.5	25.0	5.0	40.5
Baldwin	217	7.4	4.3	2.7	14.6
Ben Davis	177	9.5	5.4	3.0	18.0
Delicious	4	2.0	3.7	----------	5.7
Gano	11	11.9	5.1	4.8	21.9
Northern Spy	9	7.3	----------	----------	7.3
Rhode Island Greening	55	13.8	6.0	(2)	20.9
Rome Beauty	5	13.4	----------	1.0	14.4
Stayman Winesap	11	6.1	17.3	2.7	26.2
Willowtwig	18	21.2	----------	1.1	22.3
Winesap	65	7.9	15.8	3.5	27.3
Yellow Newtown (*Albemarle Pippin*)	36	10.2	7.3	(2)	18.1
York Imperial	162	9.1	8.6	(2)	18.3
Total or average	776	9.3	6.9	2.1	18.4
Mixed varieties	536	13.2	1.7	1.7	16.6
Miscellaneous varieties	23	15.6	8.1	5.3	29.0
Unknown varieties	3	8.6	23.3	5.0	37.0

[1] See footnote to Table 3. [2] Less than 1 per cent.

A comparison between the disease indices of varieties ordinarily not stored at all and those stored either for long or for short periods is given in Table 9.

TABLE 9.—*Disease indices for varieties ordinarily not stored at all and for those stored for either long or short periods.*

Classification.	Varieties usually not stored.			Varieties stored.		
	Number of varieties.	Cars.	Disease index.	Number of varieties.	Cars.	Disease index.
Box crop	2	5	4.4	22	2,996	11.7
Barrel crop	5	88	5.6	18	898	17.7
Total or average	----------	93	5.3	----------	3,894	13.1

The differences shown in this table are great enough to establish and emphasize the fact that the amount of disease appearing in a lot of apples depends very largely on the length of time during which it is stored. This is also borne out by the rot and scald figures and the disease indices for both crops, by months (Tables 4 and 5), and by the fact that as the storage season progresses (from November on, for both crops combined) the proportion of cars showing disease, as compared with total cars inspected, grows constantly larger. (See Table 10 for the 1920 crop.) The date of packing may be of some significance, though if varieties are picked and packed early they are generally marketed early. Their storage season is thus no longer and, in fact, is usually shorter than that of midseason or late varieties. Frequently they are not stored at all.

TABLE 10.—*Percentage of cars showing disease, by months, crop of 1920, calculated on the basis of total cars inspected each month.*

Month.	Barrel crop.	Box crop.	Barrel and box crop combined.
	Per cent.	*Per cent.*	*Per cent.*
July	79.5	----------	78.0
August	73.6	6.6	72.7
September	64.4	----------	63.6
October	71.6	21.4	48.2
November	55.9	16.3	35.5
December	70.3	25.0	36.8
January	74.8	29.8	43.0
February	81.2	36.8	54.0
March	82.7	70.5	73.4
April	84.6	83.2	83.7
May	100.0	93.7	94.3
June	100.0	96.4	96.8
Average	71.5	51.4	58.2

BOX CROP: DISEASE BY STATES.

Little is noteworthy here (Table 11) except that of the States which were represented by more than 100 cars—Idaho, Oregon, and Washington, total 3,517 cars—Idaho showed approximately a half more rot and a slightly larger disease index than either Oregon or Washington.

TABLE 11.—*Summary, box crop, by States, 1917 to 1920.*

State.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
		Per cent.	*Per cent.*	*Per cent.*	
California	52	7.1	2.6	(2)	10.0
Colorado	77	7.1	1.0	(2)	8.6
Idaho	134	9.7	2.8	1.0	13.5
Oregon	288	6.3	5.5	(2)	12.7
Washington	3,095	6.7	5.2	(2)	12.4
All others	28	6.5	(2)	2.3	9.0
Total or average	3,674	6.8	5.0	(2)	12.6

[1] See footnote to Table 3.

[2] Less than 1 per cent.

BARREL CROP: DISEASE BY STATES.

In the four States represented by more than 75 cars—New York, Virginia, West Virginia, and Michigan, total 1,051 cars—the average percentage of rot (Table 12) was 8.7, the average of the disease indices 15.7. In all other States and in Canada, with a total of 497 cars, the average for rots was 14.4 per cent; for disease indices, 19.2.

TABLE 12.—*Summary, barrel crop, by States and in Canada, 1917 to 1920.*

State (also includes Canada).	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
		Per cent.	*Per cent.*	*Per cent.*	
Arkansas	60	20.0		(2)	20.8
Canada	25	22.3	6.6	4.0	32.9
Delaware	22	12.3	(2)		12.8
Illinois	74	18.5	3.1	4.0	26.0
Maine	40	9.0	4.8	1.1	15.0
Maryland	61	7.8	3.0		10.9
Michigan	89	7.0		(2)	7.9
Missouri	40	12.8	1.2		14.0
New York	493	8.7	3.5	1.5	14.2
Ohio	18	12.1		1.4	13.5
Pennsylvania	59	13.4	5.9	2.5	21.7
Virginia	334	8.9	9.6	3.0	21.5
West Virginia	135	9.3	2.8	1.3	13.5
All others	98	14.0	2.0	3.4	19.5
Total or average	1,548	10.5	4.3	1.9	16.8

[1] See footnote to Table 3.

[2] Less than 1 per cent.

The significance of these figures is not clear. They may have no significance at all, but on the other hand they may mean that in States where the commercial crop is large those methods of growing, handling, and storage which prevent loss are better understood and more generally used than in the States where the commercial crop is small.

BOX AND BARREL CROP: DISEASE BY INSPECTION OFFICES.

If the figures for southern offices—Atlanta, Baltimore, Fort Worth, Houston, Jacksonville, Louisville, Memphis, New Orleans, Oklahoma City, and Washington, D. C.—are compared, in both barrel and box crop, with figures for all other offices (see Tables 13 and 14) it is found that the former are, on the average (Table 15), larger than the latter. That is, there was greater loss from disease in cars shipped to southern markets than in cars shipped to other markets of the country.

TABLE 13.—*Summary, box crop, by inspection offices, 1917 to 1920.*

Office.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
		Per cent.	*Per cent.*	*Per cent*	
Atlanta	90	8.7	5.4	(2)	14.2
Baltimore	98	7.6	10.8	(2)	18.9
Boston	113	4.1	3.7	(2)	8.5
Buffalo	86	9.7	5.4	(2)	16.0
Chicago	748	4.8	6.5	(2)	11.7
Cincinnati	97	7.1	4.0	1.5	12.6
Cleveland	88	10.6	3.4	(2)	14.8
Columbus	46	8.1	5.8	(2)	14.4
Denver	10	6.7	----------	----------	6.7
Des Moines	1	30.0	----------	----------	30.0
Detroit	58	8.1	5.1	(2)	13.4
Fort Worth	163	7.6	3.0	3.0	13.7
Houston	166	6.6	2.2	3.0	11.8
Indianapolis	24	9.8	4.4	(2)	15.1
Jacksonville	8	24.8	1.8	----------	26.7
Kansas City	141	8.6	1.5	(2)	10.8
Los Angeles	3	3.3	----------	2.0	5.3
Louisville	1	6.0	55.0	----------	61.0
Memphis	32	7.1	16.2	(2)	23.8
Milwaukee	91	8.9	5.6	1.3	15.8
Minneapolis	138	7.0	3.3	(2)	11.1
New Orleans	85	8.1	4.3	(2)	12.6
New York	458	7.2	6.0	(2)	14.1
Oklahoma City	2	15.0	----------	----------	15.0
Omaha	62	5.3	(2)	----------	6.2
Philadelphia	387	5.8	4.7	(2)	10.8
Pittsburgh	324	6.4	5.0	(2)	11.9
Portland, Oreg	2	15.0	15.0	----------	30.0
St. Louis	58	7.0	5.4	(2)	12.8
San Francisco	13	8.3	----------	(2)	8.7
Washington	81	9.0	3.3	(2)	12.4
Total or average	3,674	6.8	5.0	(2)	12.6

[1] See footnote to Table 3.

(2) Less than 1 per cent.

TABLE 14.—*Summary, barrel crop, by inspection offices, 1917 to 1920.*

Office.	Total cars.	Rots.	Scald.	Other diseases.	Disease index.[1]
		Per cent.	*Per cent.*	*Per cent.*	
Atlanta	54	8.7	5.9	9.2	23.9
Baltimore	32	12.6	12.7	----------	25.5
Boston	41	4.0	1.4	(2)	6.1
Buffalo	10	14.8	1.2	(2)	16.7
Chicago	131	11.2	2.1	1.0	14.3
Cincinnati	141	7.1	4.8	(2)	12.4
Cleveland	118	9.3	7.7	2.1	19.1
Columbus	20	9.2	----------	1.7	10.9
Denver	2	12.0	----------	----------	12.0
Detroit	65	19.1	2.4	1.2	22.7
Fort Worth	8	17.7	----------	(2)	18.3
Houston	13	8.8	----------	1.3	10.2
Indianapolis	72	10.6	4.3	(2)	15.2
Jacksonville	6	32.5	2.8	----------	35.3
Kansas City	58	8.2	(2)	(2)	9.4
Memphis	103	11.1	8.2	1.2	20.6
Milwaukee	39	7.7	5.9	4.1	17.8
Minneapolis	79	9.0	5.5	(2)	15.5
New Orleans	68	8.6	8.1	5.0	21.8
New York	135	13.8	4.7	2.7	21.2
Oklahoma City	2	27.5	----------	----------	27.5
Omaha	8	4.3	----------	----------	4.3
Philadelphia	43	9.5	4.2	2.4	16.0
Pittsburgh	262	10.0	1.7	2.4	14.4
St. Louis	27	14.7	3.8	1.3	19.9
Washington	11	24.0	5.9	----------	30.0
Total or average	1,548	10.5	4.3	1.9	16.7

[1] See footnote to Table 3.

(2) Less than 1 per cent.

TABLE 15.—*Disease in cars arriving at southern inspection offices*[1] *and at all other offices, classified as rots, scald, and other diseases, crops of 1917 to 1920.*

Classification.	Southern offices.				All other offices.			
	Rots.	Scald.	Other diseases.	Disease index.[2]	Rots.	Scald.	Other diseases.	Disease index.[2]
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	
Barrel crop	11.3	7.4	3.3	22.2	10.3	3.5	1.6	15.4
Box crop	7.9	5.0	1.6	14.5	6.5	5.0	.4	12.0

[1] Atlanta, Ga.; Baltimore, Md.; Fort Worth and Houston, Tex.; Jacksonville, Fla.; Louisville, Ky.; Memphis, Tenn.; New Orleans, La.; Oklahoma City, Okla.; and Washington, D. C.

[2] See footnote to Table 3.

The only figure that fails to support the above statement is that for scald in the box crop, where the average, calculated on the basis of all cars showing disease, is no larger for southern offices than for "all other offices."

If the comparison is made by years (Table 16), using only the disease index rather than its constituent parts—rots, scald, and other diseases—it appears that in only one instance (barrel crop of 1917) was the figure for southern offices less than that for all other offices. This is the smallest group of cars that appears in the table and is of little significance as compared with the barrel-crop inspections for 1919 and 1920.

TABLE 16.—*Disease indices for cars arriving at southern inspection offices*[1] *and at all other offices, by years.*

Year.	Barrel crop.				Box crop.			
	Southern offices.		All other offices.		Southern offices.		All other offices.	
	Cars.	Disease index.[2]	Cars.	Disease index.[2]	Cars.	Disease index.[2]	Cars.	Disease index.[2]
1917	13	30.4	40	35.4	49	20.1	184	16.8
1918	26	25.4	91	15.7	28	19.3	191	12.6
1919	114	18.7	456	18.4	462	11.8	1,622	10.6
1920	143	23.6	665	12.7	187	18.9	951	13.5
Total or average	296	22.2	1,252	15.4	726	14.5	2,948	12.0

[1] See footnote 1 to Table 15.

[2] See footnote to Table 3.

The difference is still apparent if a comparison is made (1) of scald figures for southern offices, calculated on the basis of cars showing scald (Table 17), with other scald figures, similarly calculated for all other offices; (2) of disease indices in shipments from States where part went to southern and part to other offices of the inspection service. (See Table 18 and fig. 4, which give such data for the barrel crop of 1920.)

TABLE 17.—*Scald in cars arriving at southern inspection offices*[1] *and at all other offices, calculated on the basis of cars showing scald, crops of 1917 to 1920.*

Classification.	Southern offices.		All other offices.	
	Cars.	Per cent.	Cars.	Per cent.
Box crop	182	20.0	1,009	14.8
Barrel crop	55	40.0	153	29.4
Total or average	237	24.7	1,162	16.7

[1] See footnote 1 to Table 15.

TABLE 18.—*Barrel crop, 1920; disease index for shipments from States where part went to southern inspection offices*[1] *and part to other offices of the inspection service.*

State.	Southern offices.			All other offices.		
	Number of cars inspected.	Number of cars showing disease.	Disease index.[2]	Number of cars inspected.	Number of cars showing disease.	Disease index.[2]
Arkansas	3	1	53.0	4	2	10.0
Illinois	1	1	31.0	35	28	18.0
Kentucky	4	3	5.3	----------	----------	----------
Maryland	15	14	9.8	31	20	8.0
Michigan	1	----------	----------	67	45	6.2
New York	21	12	21.0	543	362	11.6
Pennsylvania	15	9	26.0	46	31	19.6
Virginia	90	80	27.6	100	84	18.4
West Virginia	29	23	14.7	55	41	6.5
Total or average	179	143	23.6	881	613	12.6
Other States [2]	----------	----------	----------	70	52	16.6

[1] See footnote 1 to Table 15.

[2] See footnote to Table 3.

[3] No shipments from these States were inspected at southern offices.

It appears from Table 18 that for seven out of the nine States represented, shipments which went to southern offices suffered most. Kentucky cars were inspected only at southern offices; of the Michigan cars only one was inspected at a southern office, and it showed no disease. Taking a general average for the nine States, the disease index for southern offices was 23.6; for all other offices, 12.6.

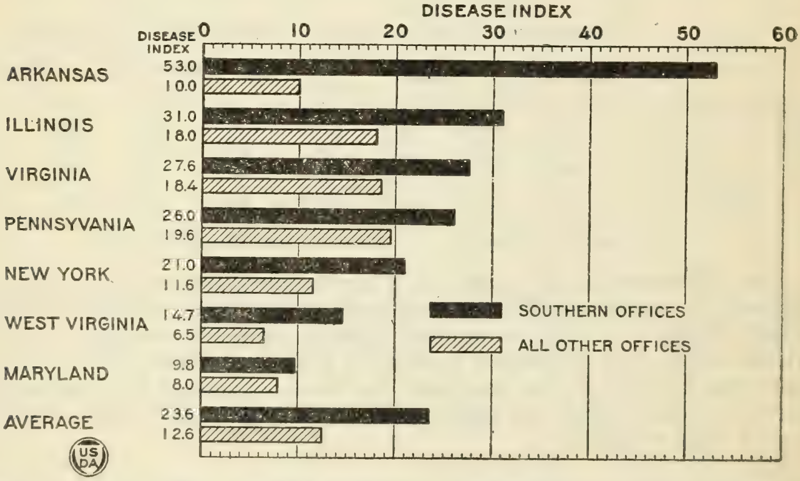

FIG. 4.—Barrel crop for 1920. Disease index for cars from seven States, part of which were inspected at southern inspection offices, and part at all other inspection offices. The percentages are calculated on the basis of all cars showing disease of any kind.

It appears, further, from Tables 15 and 17 that differences in disease index between southern offices and all other offices were greater in the barrel than in the box crop. (Compare 22.2 per cent at southern offices, and 15.4 per cent at all other offices for the barrel crop with 14.5 per cent at southern offices, and 12 per cent at all other offices for the box crop.)

There may be several reasons for the excess of disease in apples shipped to southern markets. Probably the most important one is that apple shipments moving to southern markets are subjected to higher outside temperatures than are those which go to other markets. And higher temperatures mean more rapid development of disease. As for the more marked difference in the barrel crop between shipments to southern and to other markets, about the only thing that can be said is that it seems to exist. It may be due in part to the fact that shippers operating in several of the eastern apple-growing States—Arkansas, Missouri, New York, Maryland, and the Virginias—very often send their poorer grade stock to southern markets. But there is no way of knowing whether or not the cars of the barrel crop which went to southern markets were actually in poor condition when shipped. Explanation of the difference must therefore wait for further investigation.

DISEASE BY CROPS: BARREL AND BOX.

The percentage of rots, scald, and other diseases and the disease index, all calculated on the basis of all cars showing disease, are given in the various tables. Referring merely to totals, based on 3,674 cars in the box crop and 1,548 in the barrel crop, it will be seen that the percentage of rots was about one-half larger in the barrel than in the box crop; of scald, slightly larger in the box than in the barrel crop; of other diseases, nearly three times as large in the barrel as in the box crop. The disease index for the barrel crop, 16.8, was exactly one-third larger than the corresponding figure, 12.6, for the box crop. Reference to Tables 1 and 2 will show that the average percentage of blue-mold rot, calculated on the basis of cars showing the rot, was about the same in both crops—7.5 in the box crop, 8.3 in the barrel crop. The larger total percentage of rot in the barrel crop is therefore plainly due to the fact that the barrel crop was affected not only by blue-mold rot but by a diversity of others—black-rot, brown-rot, gray-mold rot, Alternaria rot, Rhizopus rot, pink-mold rot, and bitter-rot. In the box crop the only other diseases besides blue-mold rot were Alternaria rot and anthracnose. There is the further fact that disease noted merely as "decay" averaged 9.3 per cent in the box crop and 15.3 per cent in the barrel crop.

An expression of the difference between the two crops, independent of percentages, can be obtained by comparing, for each crop, the total number of cars showing disease with the total number inspected. If this be done for 1920, the only year in which the necessary figures are available, it is found that in the barrel crop 71 per cent of the cars inspected showed disease and in the box crop only 51 per cent (Table 10).

If more complete data were at hand it might be possible, and if possible would certainly be worth while, to show the relation between disease in the two crops and the conditions under which each is grown and marketed. There are differences, of course, in soil, climate, and orchard practice between the two sections of the country which these crops represent; there is also the difference in source of water supply—that is, between rainfall in the East and irrigation in the West. There is a further difference, easily overemphasized, in the picking and packing methods in use for the two crops. Careful handling of apples is always important, and the packing houses of the West and Northwest are famous for the care they use in handling fruit. Yet it would be a mistake to assume that all western apples are handled well and all eastern apples poorly. It would be equally wide of the truth to assume that careful handling or any other one factor is alone responsible for the differences here shown to exist between the two crops in susceptibility to disease and in general keeping quality. As a matter of fact, such differences are the result of all the factors that have affected the fruit throughout its whole history.

SCALD BY CROPS.

In Tables 19 and 20 are given figures showing the percentages of scald by varieties, by months, for both barrel and box crops, calculated on the basis of cars showing scald.

For the box crop, Table 19 shows that while a relatively small amount of scald appeared as early as November or December in Grimes Golden, Ortley, Yellow Newtown, Rome Beauty, or Winter Banana, the disease did not become serious until February and usually reached its greatest proportions in March.

In the barrel crop (Table 20) scald did not appear until December; it began to be serious in January, a month earlier than in the box crop, and reached the maximum in March.

TABLE 19.—*Summary, box crop, 1917–1920, scald by varieties, by months.*

Variety.	November.		December.		January.		February.		March.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Arkansas (*Mammoth Black Twig*)							1	15.0	5	24.4
Arkansas Black							1	3.0	6	33.5
Ben Davis					1	4.0			6	17.1
Delicious					1	15.0			1	1.0
Esopus Spitzenburg									1	12.0
Gano							1	2.0	2	28.5
Grimes Golden	1	75.0	1	52.0						
Jonathan					1	11.0	3	4.3	2	9.5
McIntosh					1	2.0				
Ortley	1	12.0	1	3.0					6	15.3
Rome Beauty			2	7.0	3	14.3	25	17.1	62	30.8
Stayman Winesap							8	17.7	8	15.6
Wagener					2	9.5	1	70.0		
White Pearmain					1	15.0	4	35.5	6	22.0
Winesap					4	8.2	16	16.6	117	8.2
Winter Banana			1	15.0						
Yellow Newtown			2	2.0	3	5.0	23	14.7	85	21.8
Mixed varieties	1	1.0	3	13.6	2	13.0	18	11.9	94	14.6
Total or average	3	29.3	10	12.9	19	9.6	101	16.1	401	17.3

Variety.	April.		May.		June.		Total.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Arkansas (*Mammoth Black Twig*)							6	22.8
Arkansas Black	10	18.8	1	5.0			18	22.0
Ben Davis	6	9.8	1	10.0			14	12.5
Delicious	1	2.0					3	6.0
Esopus Spitzenburg							1	12.0
Gano	1	8.0					4	16.7
Grimes Golden							2	63.5
Jonathan							6	7.1
McIntosh							1	2.0
Ortley	2	8.0					10	12.3
Rome Beauty	12	41.0	1	25.0			105	27.8
Stayman Winesap	3	21.6					19	17.4
Wagener							3	29.6
White Pearmain	1	7.0	2	15.5			14	23.3
Winesap	200	11.3	190	13.3	118	17.1	645	12.5
Winter Banana							1	15.0
Yellow Newtown	44	20.5	7	17.0	1	7.0	165	19.6
Mixed varieties	39	13.8	13	14.5	4	19.7	174	14.2
Total or average	319	14.2	215	13.0	123	16.2	1,191	15.6

TABLE 20.—*Summary, barrel crop, 1917–1920, scald by varieties, by months.*

Variety.	December.		January.		February.		March.		April.		May.		June.		Total.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Arkansas (*Mammoth Black Twig*)			1	50.0			1	100.0							2	75.0
Baldwin					4	11.0	20	29.8	9	11.1	5	42.4			38	25.0
Ben Davis			1	25.0	3	3.6	13	45.8	3	37.6	5	33.4	2	22.5	27	35.4
Delicious							1	15.0							1	15.0
Gano									3	19.0					3	19.0
Grimes Golden	1	80.0													1	80.0
Peck Pleasant							1	83.0							1	83.0
Rhode Island Greening			4	26.7	4	8.7	6	29.8			1	15.0			15	22.4
"Russet"									1	13.0					1	13.0
Stark							1	10.0							1	10.0
Stayman Winesap					2	45.5	1	100.0							3	63.7
Sweetheart							1	5.0							1	5.0
Tolman Sweet							1	90.0							1	90.0
Tompkins King							2	30.0							2	30.9
Winesap			1	4.0	8	48.0	12	43.0	3	42.3					24	42.9
Yellow Newtown							2	38.5	6	28.0	3	6.0			11	23.2
York Imperial	1	15.0	12	37.1	20	43.4	2	38.5							35	40.0
Yellow Transparent													1	25.0	1	25.1
Mixed varieties	1	10.0	3	16.0	14	21.0	9	17.1	8	45.3	4	18.5			39	24.0
Unknown varieties											1	70.0			1	70.3
Total or average	3	35.0	22	30.9	55	31.4	73	36.4	33	28.5	19	29.2	3	23.1	208	32.0

Including all varieties that showed the disease, the average percentage of scald in the box crop was 15.6 (Table 19), in the barrel crop 32.8 (Table 20). (See also Tables 21 and 22 and figs. 5, 6, and 7.) If only those varieties be included which are common to both crops, the average percentages were 14.2 and 38.1, respectively (Table 21). That is to say, when percentage of scald is calculated on the basis of cars in which it appeared, the figure for the barrel crop is more than twice as large as that for the box crop.

These figures, particularly as they appear in Table 21, may mean that the eastern crop is more susceptible to scald than the western; more probably they mean that the barrel, so far as ventilation and scald are concerned, is a poor package in which to store apples.

It is true that when percentage of scald is calculated on the basis of all cars showing any disease, there is practically no difference between the figures for the box and the barrel crop (Tables 4 and 5). It is also true that in the box crop a larger percentage of the cars examined showed scald than showed it in the barrel crop. For the 1920 crop after January 1, the beginning of the scald season, the figure is 42 per cent for the box crop and 31 per cent for the barrel crop. The figures show plainly enough, however, that in cars where it occurred scald was more than twice as bad in eastern as in western apples.

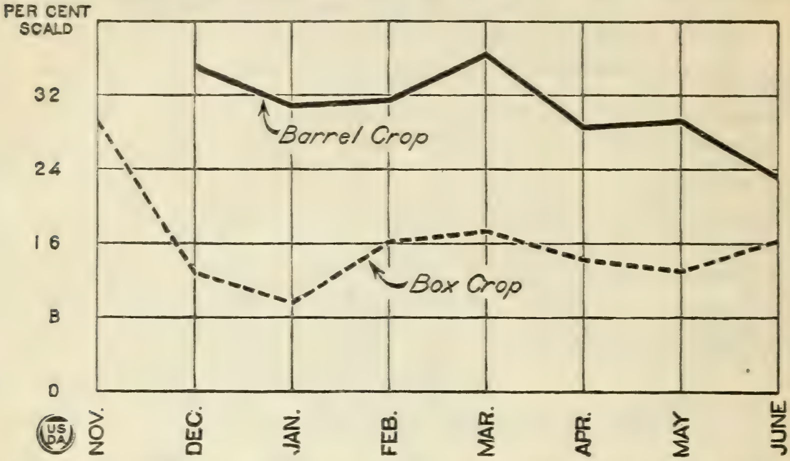

FIG. 5.—Percentages of scald by months, for the box and barrel crops for the four crop years, 1917 to 1920, inclusive, calculated on the basis of all cars showing scald.

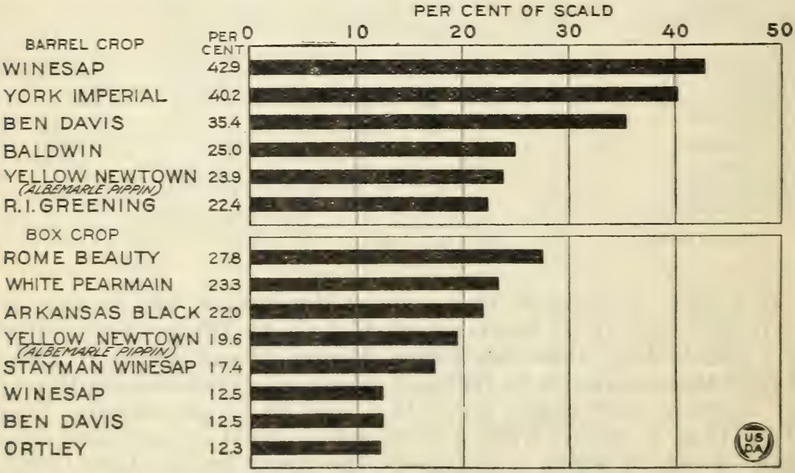

FIG. 6.—Percentages of scald found in important commercial varieties of apples for the box and barrel crops for the four crop years, 1917 to 1920, inclusive. The percentages are calculated on the basis of all cars showing scald.

With reference to Figure 6 and Table 20, it should be noted that the differences there shown, among varieties, are those found at the time of inspection, not those which would occur if all the varieties were stored under the same conditions for the same length of time.

For example, York Imperial and Rhode Island Greening in the barrel crop are known to be much more susceptible to scald than is Winesap. Yet because of this known susceptibility they are usually marketed early (to avoid scald) and so appear in the table as actually less susceptible than Winesap. The same seeming contradiction can be noted in several other instances in both the barrel and the box crop. This qualification does not hold, however, for all varieties or at all times. Apples are not always taken out of storage because scald has developed or is expected to develop soon, but often merely because the condition of the market indicates that it is a good time to sell. Furthermore, inspection is frequently asked for on cars that are not moved until much later.

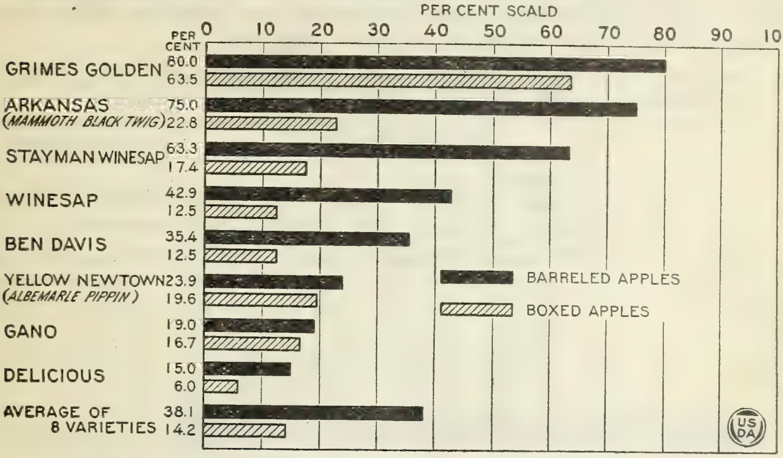

FIG. 7.—Percentages of scald in varieties that occur in the box and barrel crops, for the four crop years, 1917 to 1920, inclusive. The percentages are calculated on the basis of all cars showing scald.

TABLE 21.—*Scald in box and barrel crops on varieties that appear in both crops, 1917 to 1920, calculated on the basis of cars of these varieties in which scald appeared.*

Variety.	Box crop.		Barrel crop.	
	Cars.	Per cent.	Cars.	Per cent.
Arkansas (*Mammoth Black Twig*)	6	22.8	2	75.0
Ben Davis	14	12.5	27	35.4
Delicious	3	6.0	1	15.0
Gano	4	16.7	3	19.0
Grimes Golden	2	63.5	1	80.0
Yellow Newtown (*Albemarle Pippin*)	165	19.6	11	23.9
Stayman Winesap	19	17.4	3	63.3
Winesap	645	12.5	24	42.9
Total or average	858	14.2	72	38.1

TABLE 22.—*Scald in box and barrel crops calculated on the basis of cars in which it appeared, by years.*

Year.	Box crop.		Barrel crop.	
	Cars.	Per cent.	Cars.	Per cent.
1917	98	19.0	16	31.8
1918	31	13.4	6	30.5
1919	425	18.0	49	40.0
1920	637	13.8	137	29.7
Total or average	1,191	15.6	208	32.3

RELATION OF ROTS, SCALD, INTERNAL BREAKDOWN, AND WATER-CORE TO SIZE AND GRADE.

The data given in Table 23 and shown graphically in Figure 8 were compiled from certificates on which the inspector had recorded the relation between disease and either size or grade. There is no way of knowing what would have been the result if a similar notation had been made on every car inspected, and there is no intent to imply, in this discussion, that the conditions found in a few cars were necessarily the same as those prevailing in all.

TABLE 23.—*Box crop, 1919 and 1920, relation of blue-mold rot and decay, internal breakdown, scald, and water-core to size and grade, by months.*

Month.	Blue-mold rot and decay.								Internal breakdown.			
	Extra Fancy grade.		Fancy grade.		Large sizes.		Small sizes.		Large sizes.		Small sizes.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
October	3	7.3	3	3.0	1	8.0	1	5.0	3	7.6	3	------
November	3	1.0	3	------	8	18.2	8	6.1	2	17.5	2	5.0
December	11	6.0	11	7.2	17	14.8	17	3.1	------	------	------	------
January	2	3.0	2	3.5	11	6.3	11	2.5	3	28.0	3	------
February	6	15.1	6	13.0	17	20.8	17	4.7	1	17.0	1	------
March	13	17.6	13	12.0	29	13.7	29	4.4	1	7.0	1	10.0
April	3	2.6	3	13.0	17	13.2	17	5.3	------	------	------	------
May	8	11.6	8	14.3	12	18.6	12	6.0	1	8.0	1	10.0
June	6	4.3	6	10.1	2	14.5	2	2.0	------	------	------	------
Total or average	55	9.9	55	9.9	114	14.9	114	4.4	11	15.8	11	2.7

Month.	Scald.								Water-core.			
	Extra Fancy grade.		Fancy grade.		Large sizes.		Small sizes.		Large sizes.		Small sizes.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
October	------	------	------	------	------	------	------	------	------	------	------	------
November	------	------	------	------	------	------	------	------	2	28.5	2	5.0
December	------	------	------	------	1	40.0	1	10.0	4	44.0	4	1.0
January	------	------	------	------	------	------	------	------	------	------	------	------
February	3	41.6	3	25.0	2	14.5	2	6.5	------	------	------	------
March	14	14.9	14	32.0	11	29.4	11	6.0	------	------	------	------
April	5	5.4	5	18.8	5	19.6	5	6.2	------	------	------	------
May	13	11.4	13	19.7	13	23.4	13	3.0	------	------	------	------
June	6	8.0	6	20.3	3	24.0	3	2.0	------	------	------	------
Total or average	41	13.6	41	24.3	35	25.0	35	4.6	6	38.8	6	2.3

In Table 23 the following facts stand out: (1) The percentages of blue-mold rot and "decay" are about the same in both Extra Fancy and Fancy—55 cars—but more than three times as great in large sizes (125's and larger) as in small (138's and smaller)—114 cars; (2) the percentages of scald are about one and three-fourths times as great in Fancy as in Extra Fancy—41 cars—and more than five times as great in large sizes as in small—35 cars; (3) the percentages of internal breakdown and water-core show no relation to grade, but are much greater for both in large sizes than in small. The ratio for internal breakdown is about 6 to 1, 11 cars; for water-core, 16 to 1, 6 cars.

So far as this evidence goes, then, there is a pronounced susceptibility to disease in large-sized apples; in other words, large apples of a given variety do not keep as well as small ones of the same variety. This was well exemplified in Chicago in March, 1921, when a survey of the apple market showed that large sizes of Winesap and Rome Beauty were scarce, while small sizes were in good supply. Such a condition may have been due to the rather high percentage of small sizes in the 1920 crop, but in the writer's opinion can fairly be taken as proof that dealers were suspicious enough of the large sizes to move them early.

Weakness in large apples appears to be a fact, but the causes of it are rather obscure. Large apples are usually more mature than small ones and for that reason are more easily damaged by rough handling, which results in skin breaks and the entrance of decay fungi. The very weight of such apples may also cause them to suffer more than small ones from rough handling. There is ample evidence that they are usually coarser in texture, and it may be that texture in apples is an important factor in determining their susceptibility to disease.

In the matter of scald, however, overmaturity can scarcely be the main reason why large apples are more seriously affected, since the work of Brooks, Cooley, and Fisher[3] and other investigators has shown that the greatest susceptibility to the disease is found in immature fruit. Such fruit is always poorly colored and always more susceptible to scald. In fact, Table 23 shows scald to have been worse in the Fancy than in the Extra Fancy grade; that is, in the grade which by definition is poorly colored. It is true that lack of color is not the only reason for barring apples from the Extra Fancy grade, but in spite of that fact, the percentage of color shown is one of the chief differences between the two grades.

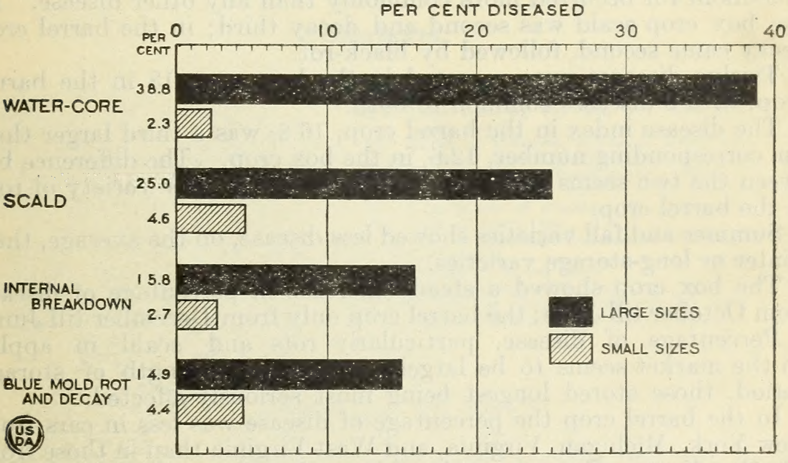

FIG. 8.—Percentages of water-core, scald, internal breakdown, and blue-mold rot and decay in large and small sizes of apples, for the four crop years, 1917 to 1920, inclusive.

The relation between scald and grade should not, however, be allowed to obscure the fact that there is often a very marked relation between scald and size.

FREEZING INJURY.

The number of cars showing freezing injury in 1919 and 1920, distributed by crop and month, is given in Table 24. Data available on the crops of 1917 and 1918 were incomplete and are not included. The effect of the severe winter of 1919–20 is shown by the fact that cars showing freezing injury were nearly five times as numerous during that winter as during the much milder winter of 1920–21.

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[3] Charles Brooks, J. S. Cooley, and D. F. Fisher. Apple scald. *In* Jour. Agr. Research, v. 16, p. 195–217. 1919.

TABLE 24.—*Summary of cars showing freezing injury, 1919 and 1920, by months.*

Month	Box crop.		Barrel crop.		Total.
	1919	1920	1919	1920	
November	4	11		45	60
December	425	49	22	31	527
January	305	56	26	19	406
February	259	26	20	17	322
March	231	13	21	4	269
April	24		1	3	28
May	3			2	5
Total[1]	1,251	155	90	121	1,617

[1] Total for 1919, 1,341 cars; total for 1920, 276 cars.

SUMMARY.

The foregoing analysis shows that so far as can be judged from inspections by the Bureau of Markets there is a great variety of diseases in the commercial apple crop of the United States and a rather heavy loss from disease in a portion of that crop.

Considering the inspections for the four-year period as a whole blue-mold rot occurred more commonly than any other disease. In the box crop scald was second and decay third; in the barrel crop decay came second, followed by black-rot.

Twelve diseases were reported in the box crop, 18 in the barrel crop, with 9 diseases common to both.

The disease index in the barrel crop, 16.8, was a third larger than the corresponding number, 12.6, in the box crop. The difference between the two seems to be due largely to the greater variety of rots in the barrel crop.

Summer and fall varieties showed less disease, on the average, than winter or long-storage varieties.

The box crop showed a steady increase in percentage of disease from October till June; the barrel crop only from December till June.

Percentage of disease, particularly rots and scald in apples on the market seems to be largely a matter of length of storage period, those stored longest being most seriously affected.

In the barrel crop the percentage of disease was less in cars from New York, Michigan, Virginia, and West Virginia than in those from all other Eastern States considered as a whole.

The percentage of disease in the box crop was slightly heavier in cars from Idaho than in those from all other Western States considered as a whole.

Cars which went to southern inspection offices showed, on the average, more loss from disease than those which went to other inspection offices. Differences between the two groups of offices were greater for the barrel than for the box crop.

If percentage of scald is calculated on the basis of cars showing disease of any kind, it is found to be about the same in both crops. But if calculated on the basis of cars showing scald, it is more than twice as large in the barrel as in the box crop.

Data from a relatively small number of cars indicate that large apples are more susceptible than small ones to blue-mold rot, decay, scald, internal breakdown, and water-core and that apples in the Fancy grade suffer more from scald than do those in the Extra Fancy grade.

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